

## TRANSMITTAL LETTER TO THE UNITED STATES

112740-374

DESIGNATED/ELECTED OFFICE (DO/EO/US)

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR

CONCERNING A FILING UNDER 35 U.S.C. 371

10/019576

INTERNATIONAL APPLICATION NO.

INTERNATIONAL FILING DATE

PRIORITY DATE CLAIMED

PCT/DE00/01542

16 May 2001 2020

23 June 1999

TITLE OF INVENTION

METHOD FOR CONTROLLING THE TRANSMISSION POWER IN A RADIO SYSTEM, AND A  
CORRESPONDING RADIO SYSTEM

APPLICANT(S) FOR DO/EO/US

Bernhard Raaf

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (24) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
  - a. ☒ is attached hereto (required only if not communicated by the International Bureau).
  - b. ☐ has been communicated by the International Bureau.
  - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
  - a. ☒ is attached hereto.
  - b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
  - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
  - b. ☐ have been communicated by the International Bureau.
  - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
  - d. ☒ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
10. ☒ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).
11. ☒ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☒ A copy of the International Search Report (PCT/ISA/210).

## Items 13 to 20 below concern document(s) or information included:

13. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☒ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
20. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
21. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
22. ☒ Certificate of Mailing by Express Mail
23. ☐ Other items or information:

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR

INTERNATIONAL APPLICATION NO.

ATTORNEY'S DOCKET NUMBER

10/019576

PCT/DE00/01542

112740-374

24. The following fees are submitted:

**BASIC NATIONAL FEE ( 37 CFR 1.492 (a) (1) - (5) ) :**

- ☐ Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO ..... \$1040.00
- ☒ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO ..... \$890.00
- ☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO ..... \$740.00
- ☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) ..... \$710.00
- ☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) ..... \$100.00

**ENTER APPROPRIATE BASIC FEE AMOUNT =****\$890.00**Surcharge of \$130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).**\$0.00**

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE
Total claims	21 - 20 =	1	x \$18.00
Independent claims	2 - 3 =	0	x \$84.00

**\$18.00****\$0.00**Multiple Dependent Claims (check if applicable). ☐**\$0.00****TOTAL OF ABOVE CALCULATIONS =****\$908.00**☐ Applicant claims small entity status. See 37 CFR 1.27). The fees indicated above are reduced by 1/2.**\$0.00****SUBTOTAL =****\$908.00**Processing fee of \$130.00 for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)).**\$0.00****TOTAL NATIONAL FEE =****\$908.00**Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) (check if applicable). ☐**\$0.00****TOTAL FEES ENCLOSED =****\$908.00****Amount to be:  
refunded****\$****charged****\$**

- a. ☒ A check in the amount of \$908.00 to cover the above fees is enclosed.
- b. ☐ Please charge my Deposit Account No. \_\_\_\_\_ in the amount of \_\_\_\_\_ to cover the above fees. A duplicate copy of this sheet is enclosed.
- c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 02-1818. A duplicate copy of this sheet is enclosed.
- d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

**NOTE:** Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

William E. Vaughan (Reg. No. 39,056)  
 Bell, Boyd & Lloyd LLC  
 P.O. Box 1135  
 Chicago, Illinois 60690-1135

SIGNATURE

William E. Vaughan

NAME

39,056

REGISTRATION NUMBER

December 19, 2001

DATE

BOX PCT

IN THE UNITED STATES ELECTED/DESIGNATED OFFICE  
OF THE UNITED STATES PATENT AND TRADEMARK OFFICE  
UNDER THE PATENT COOPERATION TREATY-CHAPTER II

5

**PRELIMINARY AMENDMENT**

APPLICANT: Bernhard Raaf . DOCKET NO: 112740-374  
SERIAL NO: GROUP ART UNIT:  
EXAMINER:

INTERNATIONAL APPLICATION NO: PCT/DE00/01542

10 INTERNATIONAL FILING DATE: 16 May 2001

INVENTION: METHOD FOR CONTROLLING THE TRANSMISSION  
POWER IN A RADIO SYSTEM, AND A  
CORRESPONDING RADIO SYSTEM

15 Assistant Commissioner for Patents,  
Washington, D.C. 20231

Sir:

Please amend the above-identified International Application before entry  
20 into the National stage before the U.S. Patent and Trademark Office under 35  
U.S.C. §371 as follows:

**In the Specification:**

Please replace the Specification of the present application, including the  
Abstract, with the following Substitute Specification:

25

**SPECIFICATION**

**TITLE OF THE INVENTION**

**METHOD FOR CONTROLLING THE TRANSMISSION POWER IN A RADIO  
SYSTEM, AND A CORRESPONDING RADIO SYSTEM**

**BACKGROUND OF THE INVENTION**

30

Control of the transmission power represents an important performance  
feature in mobile radio systems in order to suppress possible interference between  
the individual connections and, thus, to make it possible to improve the capacity  
and quality of the connections, in order to be able to reduce the mean transmission

power and to be able to match it as well as possible to the requirements, as well as to make it possible to compensate, at least partially, for losses in the transmission channels.

5 For this purpose, the signal transmitted by a transmitter is evaluated at the receiving end in the mobile radio system, in order to make it possible for this to produce information for power control and to transmit this to the transmitter, which then adjusts the transmission power in accordance with the power control or power adjustment information.

10 In this case, the power adjustment information is transmitted analogously to the transmission of the actual communication information, depending on the respective mobile radio system, embedded in a predetermined frame and timeslot structure; that is to say, the information is transmitted in a number of sequentially transmitted frames, with each frame having a specific number of timeslots. For known mobile radio systems, it has been proposed for the transmitter of the mobile  
15 radio system to be operated in a mode which is referred to as the slotted mode or compressed mode, with the information to be transmitted in this case being transmitted within specific frames in compressed form to a receiver in order to make it possible, in the appropriate frame, to produce a section which is free of information bits, and which is referred to as an idle slot, which can then be used for  
20 intermediate frequency measurements; for example, in order to prepare for a handover between different mobile radio systems. The information must be transmitted in a shorter time interval for compression.

The principle of compression is illustrated schematically in Figure 4, with a number of sequentially transmitted frames 3 being shown, each of which has an  
25 identical frame duration; for example, 10 ms. The second frame 3 shown in Figure 4 uses the slotted mode, that is to say the information is transmitted in compressed form in this frame, so that an idle slot 9 occurs in which information is now transmitted. As is likewise shown in Figure 4, the transmission power can be increased during this frame 3 that is operated in the slotted mode in order to achieve  
30 a transmission quality which is not adversely affected by the slotted mode.

However, the slotted mode interrupts the principle of fast power control. In modern mobile radio systems, power adjustment information for the transmitter is produced in each timeslot so that the transmission power can be adapted relatively quickly. However, no such power adjustment information can be transmitted during the idle slots described above. Firstly, this results in a higher error rate for the power adjustment information bits and, secondly, it must be expected that the instantaneous transmission power will deviate to a greater extent from the nominal value.

In order to overcome this problem associated with the slotted mode, it has been proposed, for example, to temporally increase the energy in what are referred to as pilot bits after the slotted mode, for power control, in order to allow correct decoding of the power adjustment information which is generally formed only by a corresponding bit with a specific mathematical sign. The pilot bits are used to estimate the channel impulse response during what is referred to as a training sequence, and they correspond to a known bit pattern. The power control procedure for the slotted mode as described in this document is, however, relatively complicated and requires a relatively large amount of effort.

The present invention is, thus, directed toward an improved method for controlling the transmission power in a radio system, and a corresponding radio system, in which case the aim is to reliably control the transmission power, particularly, in the slotted mode or compressed mode described above.

#### SUMMARY OF THE INVENTION

The present invention proposes that the same power adjustment information be transmitted in successive timeslots, so that the transmission power in the transmitter can be set with greater reliability, by evaluating the power adjustment information received during these timeslots in combination in order to adjust the transmission power.

The present invention is particularly suitable for use in what is referred to as the slotted mode, in which case the same power adjustment information is transmitted a number of times following an idle slot; that is to say, a section of a frame in which no information is transmitted. However, the present invention is

not restricted to this use in the slotted mode and can, in principle, be used also for timeslots which do not follow an idle slot in order to allow more reliable power control in these situations as well. In this case, this approach is of particular interest when the transmission conditions in the respective transmission channel are not changing rapidly (for example, when a mobile station is moving at slow speed).

In particular, the present invention proposes that the signal-to-noise ratio of the received signal be evaluated, for example, after an idle slot, that appropriate power adjustment information be produced as a function of this, and that this information be transmitted to the transmitter during the next two timeslots immediately following the idle slot. The transmitter then evaluates the power adjustment information received during these two timeslots and adjusts the transmission power taking account of both power adjustment information items so that a transmission power adjustment which may have been made on the basis of the first power adjustment information item can still be corrected.

The principle on which the present invention is based can be used both in the uplink, that is to say for transmitting communication information from a mobile station to a base station, and in the downlink, that is to say for the opposite direction, or else for both directions at the same time.

After receiving the power adjustment information in the first timeslot immediately following the idle slot, the transmission power initially can be kept constant so that no change is made until the power adjustment information in the second timeslot has been received.

Generally, the power adjustment information transmitted during each timeslot includes only one bit with the step width for changing the transmission power being coded digitally. However, instead of this, the step width also can be coded in analogue form; that is, the step width then depends, for example, directly analogously on the discrepancy between the received signal level measured in the receiver and a predetermined reference value.

The present invention requires no change whatsoever to the specified timeslot format. The combination of the successively transmitted power adjustment information items results in an improvement in the available bit-signal-noise ratio

( $E_b/N_0$ ). This increased bit-signal-noise ratio allows a greater step width to be provided for power control without any risk of an increased bit error rate more frequently resulting in the transmission power needing to be changed in the wrong direction.

5       The present invention can be used in various types of radio systems, although it is of particular interest for mobile radio systems using code division multiplexing methods (code division multiple access CDMA).

Additional features and advantages of the present invention are described in, and will be apparent from, the following Detailed Description of the Invention and  
10   the Figures.

#### BRIEF DESCRIPTION OF THE FIGURES

Figure 1 shows an illustration to explain the principle on which the present invention is based, on the basis of a preferred exemplary embodiment.

Figure 2 shows a general schematic illustration to explain the information  
15   transmission in a mobile radio system.

Figure 3 shows the frame and timeslot structure for what is referred to as a downlink connection, according to the present standard of UMTS Standardization.

Figure 4 shows an illustration to explain the frame structure in what is referred to as the slotted mode.

#### 20       DETAILED DESCRIPTION OF THE INVENTION

The principle of power control will first of all be explained in more detail with reference to Figure 2. Figure 2 illustrates the communication between a base station 1 and a mobile station 2 in a mobile radio system. A connection from the base station 1 to the mobile part 2 is referred to as a downlink or forward link,  
25   while a connection from the mobile part 2 to the base station 1 is referred to as an uplink or reverse link. For downlink power control, the respective received signal is evaluated in the mobile station 2, and power adjustment information or power control information is produced as a function of it, and is sent back to the base station 1 so that the base station 1 can set the transmission power as appropriate.

30   For uplink control, the received signal is evaluated in the base station 1, where the

power control information is produced, and the mobile station 2 is instructed to carry out power adaptation.

The power control information is, in this case, transmitted embedded in a predetermined frame structure depending on the respective mobile radio system.

5       As an example, Figure 3 shows the frame and timeslot structure for a downlink connection in a mobile radio system which is operated using a code division multiple access method (CDMA). The frame and timeslot structure shown in Figure 3 corresponds, in particular, to a UMTS mobile radio channel (Universal Mobile Telecommunications System), which is also referred to as a DPCH  
10 (Dedicated Physical CHannel), in accordance with the current state of UMTS Standardization. UMTS is the designation for third-generation mobile radio systems, aiming to provide a worldwide, universal mobile radio standard. According to the UMTS mobile radio standard, the multiple access method is what is referred to as the WCDMA method (Wideband Code Division Multiple Access).

15       The frame structure shown in Figure 3 has a duration of 720 ms and includes, in particular, 72 identically constructed frames 3 with a frame duration of 10 ms, with each frame, in turn, having 16 timeslots 4, each with a timeslot duration of 0.625 ms. Alternatively, a frame 3 may also include 15 correspondingly longer timeslots 4. However, the former situation is assumed in the following text.  
20 Each timeslot 4 includes information which is split between a logical control channel (DPCCH, Dedicated Physical Control Channel) and a logical data channel (DPDCH, Dedicated Physical Data Channel). The DPCCH section includes a pilot bit sequence 5 and what is referred to as TPC information (Transmitter Power Control) 6 and TFI information (Transmitter Format Identifier) 7. The DPDCH  
25 section includes user data bits 8.

The pilot bit sequence 5 is used for estimating the channel impulse response during what is referred to as a training sequence, and corresponds to a known bit pattern. The receiver can determine or estimate the channel impulse response of the mobile radio channel by comparing the received signal with the known pilot bit  
30 sequence.



The TFI information 7 is used for format identification for the respective receiver. The TFI bits are protected via their own coding method in accordance with the present WCDMA standard, and are distributed over an entire frame (time period 10 ms) by interleaving. If, for example, the TFI information 7 in each timeslot includes two bits, then this results in a total of  $2 \cdot 16 = 32$  TFI bits per frame, which includes 16 timeslots, and these are coded via what is referred to as a biorthogonal coding method.

The TPC information 6 represents the command, produced by the receiver and transmitted to the transmitter, to adjust the transmission power. For this purpose, the received power or the signal-to-noise ratio of the received signal is compared with a predetermined reference value in the receiver, and the value for the power adjustment command is determined as a function of the discrepancy. As such, if the received power exceeds the reference value, a command is produced to reduce the transmission power, while a command to increase the transmission power is produced if the received power is less than the predetermined reference value. Thus, depending on the comparison result, the receiver transmits a digital or binary adjustment command to the transmitter. In this case, a command to increase the transmission power (power up command) is coded by a 1, while a command to reduce the transmission power (power down command) is coded by a zero. In each case, the adjustment command is transmitted to the transmitter after appropriate modulation. In accordance with the currently discussed WCDMA Standard for UMTS mobile radio systems, the transmission is carried out via QPSK modulation (Quadrature Phase Shift Keying), as a result of which the binary 1 or 0, respectively, is mapped onto the value -1 or +1, respectively, with subsequent spreading of the power control signal.

The power adjustment or power control information, thus, generally includes only one bit, which indicates whether the transmission power should be increased or decreased at the transmission end. In order to allow this bit to be transmitted with a sufficiently low error probability, the bit is transmitted repeatedly within the TPC field 6. The TPC information shown in Figure 3, in

consequence, includes, for example, the three bits which are transmitted successively with identical information content.

However, despite the repeated transmission of the TPC bits within the TPC field 6, the error rate is increased by the previously described slotted mode or compressed mode. In order to counteract this, information 6 is to be transmitted repeatedly, with this being done especially during the two timeslots 4 which immediately follow the idle slot 9.

In order to explain this principle, Figure 1 shows, by way of example, the structure of the already previously mentioned DPCCCH control channel (see Figure 3) in a frame, assuming that the timeslots #n shown in Figure 1, is the timeslot immediately following is an idle slot; that is to say, a section which is not filled with information. The profile of the transmission power, which is set in the transmitter as a function of the respectively transmitted TPC information, is shown underneath the timeslot structure.

In the receiver, the signal-to-noise ratio of the signal being received from the transmitter at that time is measured in order to determine the TPC or power adjustment information to be transmitted during the timeslot #n is compared with a reference value and is used to produce the TPC information  $TPC_n$ . This TPC information is transmitted to the transmitter during the timeslot #n where it is decoded and used to adjust the transmission power. In this case, it is possible to wait first of all in the transmitter for reception of the TPC information  $TPC_{n+1}$  transmitted during the next timeslot #n+1, before finally setting the transmission power to the desired value, so that it is recommended that the transmission power initially be set in the transmitter in accordance with a "normal" nominal step width which corresponds to a normal  $E_b/N_0$  ratio after receiving the TPC information  $TPC_n$ . This step width is indicated by  $\Delta P_n$  in Figure 1, and corresponds to the difference between the instantaneous transmission power  $P_{n-1}$  and the transmission power  $P_n$  set after reception of the TPC information  $TPC_n$ . The value 0 may also be chosen as the step width  $\Delta P_n$  after reception of the power adjustment information  $TPC_n$  in order to keep the transmission power constant until the power adjustment

information  $TPC_{n+1}$  is received, since it is then possible to make a decision on the transmission power to be set with greater reliability.

In order to produce the TPC information to be transmitted during the next timeslot  $\#n+1$ , the TPC information from the previous timeslot is simply repeated, that is to say  $TPC_{n+1} = TPC_n$ , rather than evaluating the signal-to-noise ratio of the transmission signal once again. In this way, the ratio  $E_b/N_0$  can be increased since, after receiving the timeslot  $\#n+1$ , the TPC information  $TPC_{n+1}$  can be combined with the already previously received TPC information  $TPC_n$ , and the transmitter is thus able to set the transmission power to the desired value with greater reliability.

If, for example, the transmitter identifies the fact that the decision made as a consequence of the most recently received TPC information was incorrect, this can now be corrected. As shown in Figure 1, the transmitter can now also change the transmission power with a larger step width, thus reducing the risk of a further deterioration being caused after an incorrect TPC decision. This is indicated in Figure 1 by  $\Delta P_{n+1}$ , with both  $\Delta P_n$  and  $\Delta P_{n+1}$  indicating the step width with respect to the transmission power  $P_{n-1}$  set after the idle slot.

The principle, mentioned above, of repeated transmission of the same TPC information during successive timeslots can be applied not only to the first time after an interruption in the power control by the idle slot, but also during a normal connection. In this case, this is of particular interest for those situations in which the transmission channel does not change so fast with time, since the disadvantage, associated with the method, of an increased delay in the power control can then be more than compensated for by the advantage of better quality of the transmitted power adjustment information. Since the smallest step width for power control is currently 1 dB and, for implementation reasons, smaller values are not suitable for use in mobile stations, this provides a possible way to reduce the power control rate.

Furthermore, the present invention can be used to transmit the power adjustment information with a smaller number of TPC bits. Although this reduces the bit-signal-noise ratio ( $E_b/N_0$ ), this can be compensated for by increased transmission reliability. The use of a small number of TPC bits is advantageous to

the extent that this reduces what is referred to as the overhead, and the efficiency can thus be improved.

Furthermore, the present invention also can be used for what is referred to as a soft handover. In this case, the mobile station 2 transmits and receives data from and to a number of base stations 1. To detect the user data, the received signals from all the connections are combined, thus allowing the power of each individual connection to be reduced. The TPC power adjustment commands may, however, in general not be combined since the TPC power adjustment commands sent from different base stations 1 (via a downlink) need not be identical. Since the TPC power adjustment commands also must be evaluated very quickly, it is also generally impossible to combine them in the uplink. Otherwise, intolerable delays would occur caused by the corresponding information being passed on from one base station 1 to another base station 1. In addition to increasing the power level of the number of TPC bits, this could be overcome by use of the present invention.

Finally, the previously described invention can also be combined with the principle of analogue transmission of the step width for adjustment of the transmission power. In this case, the transmission power to be set in the transmitter and the corresponding step width are coded in analogue form rather than digitally. That is, the power adjustment information is in each case set in analogue form depending on the discrepancy between the measured received signal level and the predetermined reference value; for example, the pilot bit reception level. A discrepancy that is twice as great between the received signal level and the reference value thus results in a step width which is twice as large.

Although the present invention has been described with reference to specific embodiments, those of skill in the art will recognize that changes may be made thereto without departing from the spirit and scope of the invention as set forth in the hereafter appended claims.

## ABSTRACT OF THE DISCLOSURE

In a radio system, the transmission power is controlled by a receiver evaluating the signal from a transmitter and a determining power adjustment information as a function of this, and sending this information to the transmitter during successive timeslots, in order to control the transmission power. In what is referred to as the slotted mode, the same power adjustment information is transmitted to the transmitter in a number of successive timeslots following a section which is not filled with information.

**In the Claims:**

On page 13, cancel line 1 and substitute the following left-hand justified heading therefore:

**CLAIMS**

5           Please cancel the claims 1-21, without prejudice, and substitute the following claims therefore:

22.       A method for controlling transmission power in a radio system, the method comprising the steps of:

10           transmitting information, embedded in a frame and a time slot structure, between a transmitter and a receiver;

          evaluating a signal, which is received by the receiver from the transmitter via a transmission channel in the radio system;

15           producing power adjustment information as a function of the evaluated signal in each time slot and sending the power adjustment information to the transmitter;

          adjusting the transmission power in the transmitter as a function of the power adjustment information; and

20           transmitting identical power adjustment information from the receiver to the transmitter in a plurality of successive timeslots.

23.       A method for controlling transmission power in a radio system as claimed in claim 22, wherein the information is transmitted in compressed form in a specific frame such that a section of the frame is not filled with information and,  
25       following the section which is not filled with information, the receiver transmits identical power adjustment information to the transmitter in a plurality of successive timeslots.

24.       A method for controlling transmission power in a radio system as  
30       claimed in claim 23, wherein, following the section which is not filled with

information, the receiver transmits identical power adjustment information to the transmitter in two successive first and second timeslots.

25. A method for controlling transmission power in a radio system as  
5 claimed in claim 24, wherein the transmission power in the transmitter is adjusted as a function of both power adjustment information received in the first timeslot following the section which is not filled with information and power adjustment information received in a second section following the section which is not filled with information.

10

26. A method for controlling transmission power in a radio system as  
claimed in claim 24, wherein the signal received by the receiver from the transmitter is evaluated once again only after the transmission of the identical power adjustment information in the first and second time slots following the  
15 section which is not filled with information, and new power adjustment information is produced as a function of the re-evaluated signal and is sent to the transmitter in a next timeslot.

27. A method for controlling transmission power in a radio system as  
20 claimed in claim 24, wherein the transmission power in the transmitter is adjusted by a fixed amount after receiving the power adjustment information transmitted in the first timeslot following the section which is not filled with information, and after receiving the power adjustment information transmitted during the second timeslot following the section which is not filled with information, and taking  
25 account of the power adjustment information transmitted during the first time slot following the section which is not filled with information, a power change value is determined, and the transmission power in the transmitter is adjusted in accordance with the power change value relative to the transmission power set prior to the first adjustment.

30

28. A method for controlling transmission power in a radio system as claimed in claim 27, wherein the fixed amount corresponds to a value of zero.

29. A method for controlling transmission power in a radio system as claimed in claim 22, wherein, in the receiver, the power adjustment information is produced analogously as a function of a discrepancy between a specific evaluated parameter in the received signal and a corresponding reference value.

30. A method for controlling transmission power in a radio system as claimed in claim 23, wherein identical power adjustment information is transmitted to the transmitter in a plurality of successive timeslots which do not immediately follow the section which is not filled with information, and the transmission power in the transmitter is adjusted taking account of the power adjustment information received during the plurality of successive timeslots.

31. A method for controlling transmission power in a radio system as claimed in claim 23, wherein identical power adjustment information is transmitted to the transmitter a plurality of times in successive timeslots following the section which is not filled with information, with a plurality of repetitions being different each time.

32. A method for controlling transmission power in a radio system as claimed in claim 22, wherein the method is used during a soft handover in the mobile radio system.

33. A radio system, comprising:  
a transmitter; and  
a receiver for receiving a signal, which is transmitted from the transmitter via a transmission channel in the radio system, and for evaluating the received signal in order to produce power adjustment information as a function of



the received signal, and to send the power adjustment information to the transmitter;

wherein the transmitter adjusts the transmission power as a function of the power adjustment information received from the receiver, with information  
5 being transmitted, embedded in a frame and a timeslot structure, between the transmitter and the receiver with a signal, the receiver transmitting identical power adjustment information to the transmitter in a plurality of successive time slots.

34. A radio system as claimed in claim 33, wherein the information is  
10 transmitted in compressed form in a specific frame, such that there is a section of the frame which is not filled with information, the receiver transmitting identical power information to the transmitter in a plurality of successive time slots following the section which is not filled with information.

35. A radio system as claimed in claimed 34, wherein the receiver  
15 transmits identical power adjustment information to the transmitter to the transmitter in two successive first and second timeslots following the section which is not filled with information.

36. A radio system as claimed in claimed 35, wherein the transmitter  
20 adjusts the transmission power as a function of both power adjustment information received in the first time slot following the section which is not filled with information and power adjustment information received in a second section following the section which is not filled with information.

37. A radio system as claimed in claimed 35, wherein the receiver once  
25 again evaluates the signal, received by the receiver from the transmitter after the transmission of the identical power adjustment information in the first and second time slots following the section which is not filled with information, and produces  
30 new power adjustment information as a function of the re-evaluated signal, and sends the new power adjustment information to the transmitter in a next timeslot.

38. A radio system as claimed in claim 35, wherein the transmitter changes the transmission power by a fixed amount after receiving the power adjustment information transmitted in the first timeslot following the section which is not filled with information and, after receiving the power adjustment information received during the second timeslot following the section which is not filled with information and additionally taking account of the power adjustment information received during the first timeslot following the section which is not filled with information, determines a power change and changes the transmission power in the transmitter in accordance with the power change value.

39. A radio system as claimed in claim 38, wherein the fixed amount corresponds to a value of zero such that after receiving the power adjustment information transmitted in the first timeslot following the section which is not filled with information, the transmitter keeps the transmission power constant until reception of the power adjustment information transmitted in the second timeslot following the section which is not filled with information.

40. A radio system as claimed in claim 33, wherein the receiver produces the power adjustment information analogously as a function of a discrepancy between a specific evaluated parameter in the received signal and a corresponding reference value.

41. A radio system as claimed in claim 34, wherein the receiver also transmits identical power adjustment information to the transmitter in a plurality of successive timeslots which do not directly follow a section which is not filled with information, and the transmitter adjusts the transmission power taking account of the power adjustment information received during the plurality of successive timeslots.

42. A radio system as claimed in claim 33, wherein the radio system is a CDMA mobile radio system.

#### REMARKS

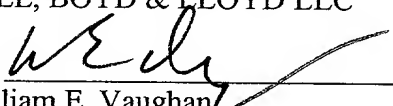
5 The present amendment makes editorial changes and corrects typographical errors in the specification, which includes the Abstract, in order to conform the specification to the requirements of United States Patent Practice. No new matter is added thereby.

10 Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page is captioned **"Versions with Markings to Show Changes Made."**

15 In addition, the present amendment cancels original claims 1-21 in favor of new claims 22-42. Claims 22-42 have been presented solely because the revisions by crossing out underlining which would have been necessary in claims 1-21 in order to present those claims in accordance with preferred United States Patent Practice would have been too extensive, and thus would have been too burdensome. The present amendment is intended for clarification purposes only and not for substantial reasons related to patentability pursuant to 35 U.S.C. §§101, 102, 103 or 112. Indeed, the cancellation of claims 1-21 does not constitute an intent on the part of the Applicants to surrender any of the subject matter of claims 1-21.

20 Early consideration on the merits is respectfully requested.

Respectfully submitted,  
BELL, BOYD & LLOYD LLC

25 BY   
William E. Vaughan  
Reg. No. 39,056  
P.O. Box 1135  
Chicago, Illinois 60690-1135  
Phone: (312) 807-4292

VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Specification:

SPECIFICATION

TITLE OF THE INVENTION

5     METHOD FOR CONTROLLING THE TRANSMISSION POWER IN A RADIO  
          SYSTEM, AND A CORRESPONDING RADIO SYSTEM

Description

~~Method for controlling the transmission power in a radio system, and a  
corresponding radio system~~

10       ~~The present invention relates to a method as claimed in the  
precharacterizing clause of claim 1 for controlling the transmission power in a radio  
system, and to a corresponding radio system as claimed in the precharacterizing  
clause of claim 12, in particular to a corresponding mobile radio system.~~

BACKGROUND OF THE INVENTION

15       Control of the transmission power represents an important performance  
feature in mobile radio systems, in order to suppress possible interference between  
the individual connections, and, thus, to make it possible to improve the capacity  
and quality of the connections, in order to be able to reduce the mean transmission  
power and to be able to match it as well as possible to the requirements, as well as  
20       to make it possible to compensate, at least partially, for losses in the transmission  
channels.

For this purpose, the signal transmitted by a transmitter is evaluated at the  
receiving end in the mobile radio system, in order to make it possible to for this to  
produce information for power control and to transmit this to the transmitter, which  
25       then adjusts the transmission power in accordance with the power control or power  
adjustment information.

In this case, the power adjustment information is transmitted analogously to  
the transmission of the actual communication information, depending on the  
respective mobile radio system, embedded in a predetermined frame and timeslot  
30       structure; that is to say, the information is transmitted in a number of sequentially  
transmitted frames, with each frame having a specific number of timeslots. For

known mobile radio systems, it has been proposed for the transmitter of the mobile radio system to be operated in a mode which is referred to as the slotted mode or compressed mode, with the information to be transmitted in this case being transmitted within specific frames in compressed form to a receiver in order to  
5 make it possible, in the appropriate frame, to produce a section which is free of information bits, and which is referred to as an idle slot, which can then be used for intermediate frequency measurements; for example, in order to prepare for a handover between different mobile radio systems. The information must be transmitted in a shorter time interval; for compression.

10 The principle of compression is illustrated schematically in Figure 4, with a number of sequentially transmitted frames 3 being shown, each of which has an identical frame duration; for example, 10 ms. The second frame 3 shown in Figure 4 uses the slotted mode, that is to say the information is transmitted in compressed form in this frame, so that an idle slot 9 occurs; in which ~~now~~ information is now  
15 transmitted. As is likewise shown in Figure 4, the transmission power can be increased during this frame 3 that is operated in the slotted mode; in order to achieve a transmission quality which is not adversely affected by the slotted mode.

However, the slotted mode interrupts the principle of fast power control. In modern mobile radio systems, power adjustment information for the transmitter is  
20 produced in each timeslot; so that the transmission power can be adapted relatively quickly. However, no such power adjustment information can be transmitted during the idle slots described above. Firstly, this results in a higher error rate for the power adjustment information bits and, secondly, it must be expected that the instantaneous transmission power will deviate to a greater extent from the nominal  
25 value.

In order to overcome this problem associated with the slotted mode, it has been proposed, for example, to temporally increase the energy in what are referred to as pilot bits after the slotted mode, for power control, in order to allow correct decoding of the power adjustment information; which is generally formed only by a  
30 corresponding bit with a specific mathematical sign. The pilot bits are used to estimate the channel impulse response during what is referred to as a training

sequence, and they correspond to a known bit pattern. The power control procedure for the slotted mode as described in this document is, however, relatively complicated, and requires a relatively large amount of effort.

5 The present invention is, thus ~~based on the object of proposing, directed~~  
toward an improved method for controlling the transmission power in a radio system, and ~~of proposing~~ a corresponding radio system, in which case the aim is to reliably control the transmission power ~~in particular even, particularly,~~ in the slotted mode or compressed mode described above.

10 ~~According to the invention, this object is achieved by a method having the features of claim 1, and by a radio system having the features of claim 12. The depending claims each define preferred embodiments of the present invention.~~

#### SUMMARY OF THE INVENTION

15 The present invention proposes that the same power adjustment information be transmitted in successive timeslots, so that the transmission power in the transmitter can be set with greater reliability, by evaluating the power adjustment information received during these timeslots in combination in order to adjust the transmission power.

20 The present invention is particularly suitable for use in what is referred to as the slotted mode, in which case the same power adjustment information is transmitted a number of times following an idle slot<sub>i</sub>; that is to say, a section of a frame in which no information is transmitted. However, the present invention is not restricted to this use in the slotted mode, ~~that is to say the invention~~ and can, in principle, ~~also~~ be used also for timeslots which do not follow an idle slot<sub>i</sub> in order to allow more reliable power control in these situations as well. In this case, this  
25 approach is of particular interest when the transmission conditions in the respective transmission channel are not changing rapidly (for example, when a mobile station is moving at slow speed).

30 In particular, the present invention proposes that the signal-to-noise ratio of the received signal be evaluated, for example, after an idle slot, that appropriate power adjustment information be produced as a function of this, and that this information be transmitted to the transmitter during the next two timeslots

immediately following the idle slot. The transmitter then evaluates the power adjustment information received during these two timeslots and adjusts the transmission power taking account of both power adjustment information items; so that a transmission power adjustment which may have been made on the basis of  
5 the first power adjustment information item can still be corrected.

The principle on which the present invention is based can be used both in the uplink, that is to say for transmitting communication information from a mobile station to a base station, and in the downlink, that is to say for the opposite direction, or else for both directions at the same time.

10 After receiving the power adjustment information in the first timeslot immediately following the idle slot, the transmission power ~~can~~ initially can be kept constant; so that no change is made until the power adjustment information in the second timeslot has been received.

Generally, the power adjustment information transmitted during each  
15 timeslot ~~comprises~~ includes only one bit; with the step width for changing the transmission power being coded digitally. However, instead of this, the step width ~~can~~ also can be coded in analogue form; that is, ~~to say~~ the step width then depends, for example, directly analogously on the discrepancy between the received signal level measured in the receiver and a predetermined reference value.

20 The present invention requires no change whatsoever to the specified timeslot format. The combination of the successively transmitted power adjustment information items results in an improvement in the available bit-signal-noise ratio ( $E_b/N_0$ ). This increased bit-signal-noise ratio allows a greater step width to be provided for power control without any risk of an increased bit error rate more  
25 frequently resulting in the transmission power needing to be changed in the wrong direction.

The present invention can be used in various types of radio ~~system~~; systems, although ~~the present invention~~ it is of particular interest for mobile radio systems using code division multiplexing methods (code division multiple access CDMA).

30 ~~The invention will be explained in more detail in the following text with reference to the drawing, based on preferred exemplary embodiments.~~

Additional features and advantages of the present invention are described in, and will be apparent from, the following Detailed Description of the Invention and the Figures.

#### BRIEF DESCRIPTION OF THE FIGURES

5        Figure 1 shows an illustration to explain the principle on which the present invention is based, on the basis of a preferred exemplary embodiment.

      Figure 2 shows a general schematic illustration to explain the information transmission in a mobile radio system.

10       Figure 3 shows the frame and timeslot structure for what is referred to as a downlink connection, according to the present standard of UMTS Standardization, and.

      Figure 4 shows an illustration to explain the frame structure in what is referred to as the slotted mode.

#### DETAILED DESCRIPTION OF THE INVENTION

15       The principle of power control will first of all be explained in more detail with reference to Figure 2, with Figure 2 ~~illustrating~~ illustrates the communication between a base station 1 and a mobile station 2 in a mobile radio system. A connection from the base station 1 to the mobile part 2 is referred to as a downlink or forward link, while a connection from the mobile part 2 to the base station 1 is referred to as an uplink or reverse link. For downlink power control, the respective  
20       received signal is evaluated in the mobile station 2, and power adjustment information or power control information is produced as a function of it, and is sent back to the base station 1; so that the base station 1 can set the transmission power as appropriate. For uplink control, the received signal is evaluated in the base  
25       station 1, where the power control information is produced, and the mobile station 2 is instructed to carry out power adaptation.

      The power control information is, in this case, transmitted embedded in a predetermined frame structure, depending on the respective mobile radio system.

30       As an example, Figure 3 shows the frame and timeslot structure for a downlink connection in a mobile radio system which is operated using a code division multiple access method (CDMA). The frame and timeslot structure shown



in Figure 3 corresponds, in particular, to a UMTS mobile radio channel (Universal Mobile Telecommunications System), which is also referred to as a DPCH (Dedicated Physical CHannel), in accordance with the current state of UMTS Standardization. UMTS is the designation for third-generation mobile radio systems, aiming to provide a worldwide, universal mobile radio standard. According to the UMTS mobile radio standard, the multiple access method is what is referred to as the WCDMA method (Wideband Code Division Multiple Access).

The frame structure shown in Figure 3 has a duration of 720 ms and ~~comprises~~ includes, in particular, 72 identically constructed frames 3 with a frame duration of 10 ms, with each frame, in turn, having 16 timeslots 4, each with a timeslot duration of 0.625 ms. Alternatively, a frame 3 may also ~~comprise~~ include 15 correspondingly longer timeslots 4. However, the former situation is assumed in the following text. Each timeslot 4 ~~comprises~~ includes information which is split between a logical control channel (DPCCH, Dedicated Physical Control Channel) and a logical data channel (DPDCH, Dedicated Physical Data Channel). The DPCCH section ~~comprises~~ includes a pilot bit sequence 5 and what is referred to as as TPC information (Transmitter Power Control) 6 and TFI information (Transmitter Format Identifier) 7. The DPDCH section ~~comprises~~ includes user data bits 8.

The pilot bit sequence 5 is used for estimating the channel impulse response during what is referred to as a training sequence, and corresponds to a known bit pattern. The receiver can determine or estimate the channel impulse response of the mobile radio channel by comparing the received signal with the known pilot bit sequence.

The TFI information 7 is used for format identification for the respective receiver. The TFI bits are protected ~~by means of~~ via their own coding method in accordance with the present WCDMA standard, and are distributed over an entire frame (time period 10 ms) by interleaving. If, for example, the TFI information 7 in each timeslot ~~comprises~~ includes two bits, then this results in a total of  $2 \cdot 16 = 32$  TFI bits per frame, which ~~comprises~~ includes 16 timeslots, and these are coded ~~by means of~~ via what is referred to as a biorthogonal coding method.

The TPC information 6 represents the command, produced by the receiver and transmitted to the transmitter, to adjust the transmission power. For this purpose, the received power or the signal-to-noise ratio of the received signal is compared with a predetermined reference value in the receiver, and the value for the power adjustment command is determined as a function of the discrepancy. This means that As such, if the received power exceeds the reference value, a command is produced to reduce the transmission power, while a command to increase the transmission power is produced if the received power is less than the predetermined reference value. Thus, depending on the comparison result, the receiver ~~thus~~ transmits a digital or binary adjustment command to the transmitter. In this case, a command to increase the transmission power (power up command) is coded by a 1, while a command to reduce the transmission power (power down command) is coded by a zero. In each case, the adjustment command is transmitted to the transmitter after appropriate modulation. In accordance with the currently discussed WDCMA Standard for UMTS mobile radio systems, the transmission is carried out ~~by means of~~ via QPSK modulation (Quadrature Phase Shift Keying), as a result of which the binary 1 or 0, respectively, is mapped onto the value -1 or +1, respectively, with subsequent spreading of the power control signal.

The power adjustment or power control information, thus, generally ~~comprises~~ includes only one bit, which indicates whether the transmission power should be increased or decreased at the transmission end. In order to allow this bit to be transmitted with a sufficiently low error probability, the bit is transmitted repeatedly within the TPC field 6. The TPC information shown in Figure 3, in consequence, ~~comprises~~ includes, for example, the three bits which are transmitted successively with identical information content.

However, despite the repeated transmission of the TPC bits within the TPC field 6, the error rate is increased by the previously described slotted mode or compressed mode. In order to counteract this, ~~before [lacuna]~~ information 6 is to be transmitted repeatedly, with this being done especially during the two timeslots 4 which immediately follow the idle slot 9.

In order to explain this principle, Figure 1 shows, by way of example, the structure of the already previously mentioned DPCCH control channel (see Figure 3) in a frame, assuming that the timeslots #n shown in Figure 1, is the timeslot immediately following is an idle slot; that is to say, a section which is not filled with information. The profile of the transmission power, which is set in the transmitter as a function of the respectively transmitted TPC information, is shown underneath the timeslot structure.

In the receiver, the signal-to-noise ratio of the signal being received from the transmitter at that time is measured in order to determine the TPC or power adjustment information to be transmitted during the timeslot #n, is compared with a reference value and is used to produce the TPC information  $TPC_n$ . This TPC information is transmitted to the transmitter during the timeslot #n, where it is decoded and used to adjust the transmission power. In this case, it is possible to wait first of all in the transmitter for reception of the TPC information  $TPC_{n+1}$  transmitted during the next timeslot #n+1, before finally setting the transmission power to the desired value, so that it is recommended that the transmission power initially be set in the transmitter in accordance with a "normal" nominal step width, which corresponds to a normal  $E_b/N_0$  ratio, after receiving the TPC information  $TPC_n$ . This step width is indicated by  $\Delta P_n$  in Figure 1, and corresponds to the difference between the instantaneous transmission power  $P_{n-1}$  and the transmission power  $P_n$  set after reception of the TPC information  $TPC_n$ . The value 0 may also be chosen as the step width  $\Delta P_n$  after reception of the power adjustment information  $TPC_n$ , in order to keep the transmission power constant until the power adjustment information  $TPC_{n+1}$  is received, since it is then possible to make a decision on the transmission power to be set, with greater reliability.

In order to produce the TPC information to be transmitted during the next timeslot #n+1, the TPC information from the previous timeslot is simply repeated, that is to say  $TPC_{n+1} = TPC_n$ , rather than evaluating the signal-to-noise ratio of the transmission signal once again. In this way, the ratio  $E_b/N_0$  can be increased since, after receiving the timeslot #n+1, the TPC information  $TPC_{n+1}$  can be combined with the already previously received TPC information  $TPC_n$ , and the transmitter is

thus able to set the transmission power to the desired value with greater reliability. If, for example, the transmitter identifies the fact that the decision made as a consequence of the most recently received TPC information was incorrect, this can now be corrected. As shown in Figure 1, the transmitter can now also change the transmission power with a larger step width, thus reducing the risk of a further deterioration being caused after an incorrect TPC decision. This is indicated in Figure 1 by  $\Delta P_{n+1}$ , with both  $\Delta P_n$  and  $\Delta P_{n+1}$  indicating the step width with respect to the transmission power  $P_{n-1}$  set after the idle slot.

The principle, mentioned above, of repeated transmission of the same TPC information during successive timeslots can be applied not only to the first time after an interruption in the power control by the idle slot, but also during a normal connection. In this case, this is of particular interest for those situations in which the transmission channel does not change so fast with time, since the disadvantage, associated with the method, of an increased delay in the power control can then be more than compensated for by the advantage of better quality of the transmitted power adjustment information. Since the smallest step width for power control is currently 1 dB and, for implementation reasons, smaller values are not suitable for use in mobile stations, this provides a possible way to reduce the power control rate.

Furthermore, the present invention can be used to transmit the power adjustment information with a smaller number of TPC bits. Although this reduces the bit-signal-noise ratio ( $E_b/N_0$ ), this can be compensated for, ~~however, by the advantage of the invention, namely~~ by increased transmission reliability. The use of a small number of TPC bits is advantageous to the extent that this reduces what is referred to as the overhead, and the efficiency can thus be improved.

Furthermore, the present invention ~~can~~ can also advantageously can be used for what is referred to as a soft handover. In this case, the mobile station 2 transmits and receives data from and to a number of base stations 1. To detect the user data, the received signals from all the connections are combined, thus allowing the power of each individual connection to be reduced. The TPC power adjustment commands may, however, in general not be combined; since the TPC power

adjustment commands sent from different base stations 1 (via a downlink) need not be identical. Since the TPC power adjustment commands ~~must~~ also must be evaluated very quickly, it is also generally impossible to combine them in the uplink. Otherwise, intolerable delays would occur, caused by the corresponding  
5 information being passed on from one base station 1 to another base station 1. In addition to increasing the power level of the number of TPC bits, this could be overcome by use of the present invention.

Finally, the previously described invention can also be combined with the principle of analogue transmission of the step width for adjustment of the  
10 transmission power. In this case, the transmission power to be set in the transmitter and the corresponding step width are coded in analogue form rather than digitally; ~~that is to say.~~ That is, the power adjustment information is in each case set in analogue form depending on the discrepancy between the measured received signal level and the predetermined reference value; for example, the pilot bit reception  
15 level. A discrepancy that is twice as great between the received signal level and the reference value thus results in a step width which is twice as large.

Although the present invention has been described with reference to specific embodiments, those of skill in the art will recognize that changes may be made thereto without departing from the spirit and scope of the invention as set forth in  
20 the hereafter appended claims.

## ABSTRACT OF THE DISCLOSURE

### Abstract

~~Method for controlling the transmission power in a radio system, and a~~  
5 ~~corresponding radio system~~

In a radio system, the transmission power is controlled by a receiver (1; 2) evaluating the signal from a transmitter (2; 1) and a determining power adjustment information (TPC) as a function of this, and sending this information to the transmitter (2; 1) during successive timeslots(4), in order to control the transmission  
10 power. In what is referred to as the slotted mode, the same power adjustment information (TPC) is transmitted to the transmitter (2; 1) in a number of successive timeslots (4) following a section (9) which is not filled with information.

(Figure 1)

1/2

FIG 1

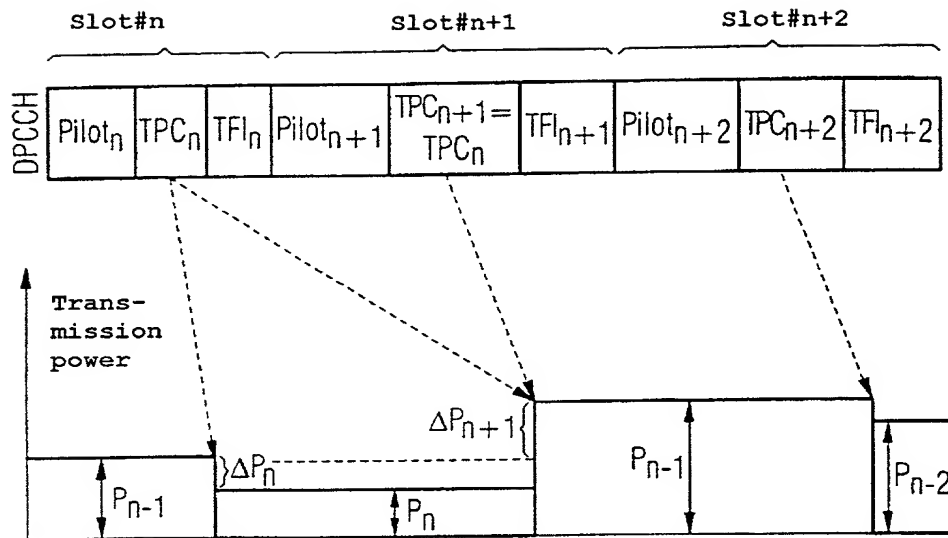


FIG 2

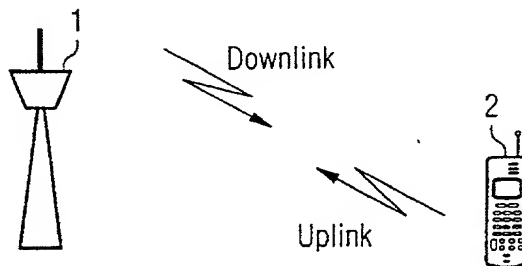


FIG 3

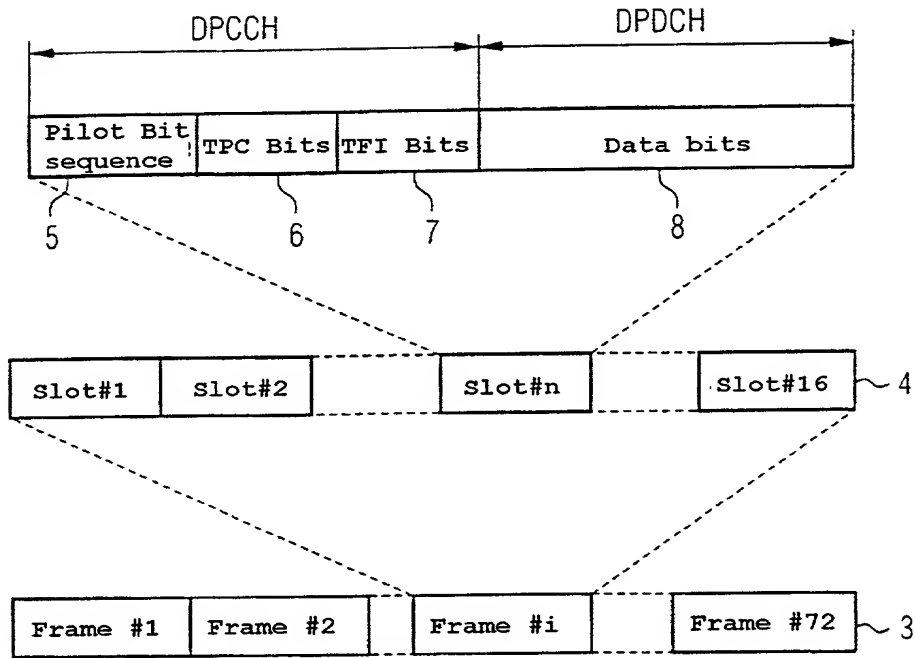
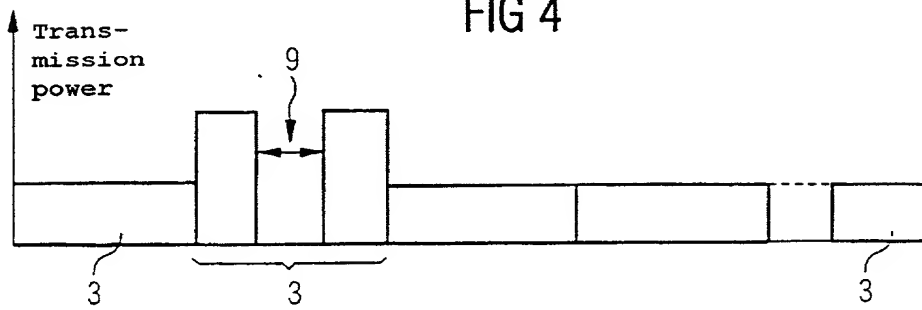


FIG 4



\*



GR 99 P 2101

## Description

Method for controlling the transmission power in a radio system, and a corresponding radio system

5

The present invention relates to a method as claimed in the precharacterizing clause of claim 1 for controlling the transmission power in a radio system, and to a corresponding radio system as claimed in the precharacterizing clause of claim 12, in particular to a corresponding mobile radio system.

Control of the transmission power represents an important performance feature in mobile radio systems, in order to suppress possible interference between the individual connections, and thus to make it possible to improve the capacity and quality of the connections, in order to be able to reduce the mean transmission power and to be able to match it as well as possible to the requirements, as well as to make it possible to compensate, at least partially, for losses in the transmission channels.

For this purpose, the signal transmitted by a transmitter is evaluated at the receiving end in the mobile radio system, in order to make it possible to this to produce information for power control and to transmit this to the transmitter, which then adjusts the transmission power in accordance with the power control or power adjustment information.

In this case, the power adjustment information is transmitted analogously to the transmission of the actual communication information, depending on the

respective mobile radio system, embedded in a predetermined frame and timeslot structure, that is to say the information is transmitted in a number of sequentially transmitted frames, with each frame having  
5 a specific number of timeslots. For known mobile radio systems, it has been proposed for the transmitter of the mobile radio system to be operated in a mode which is referred to as the slotted mode or compressed mode, with the information to be transmitted in this case  
10 being transmitted within specific frames in

compressed form to a receiver in order to make it possible, in the appropriate frame, to produce a section which is free of information bits, and which is referred to as an idle slot, which can then be used for  
5 intermediate frequency measurements, for example in order to prepare for a handover between different mobile radio systems. The information must be transmitted in a shorter time interval, for compression.

10

The principle of compression is illustrated schematically in Figure 4, with a number of sequentially transmitted frames 3 being shown, each of which has an identical frame duration, for example  
15 10 ms. The second frame 3 shown in Figure 4 uses the slotted mode, that is to say the information is transmitted in compressed form in this frame, so that an idle slot 9 occurs, in which now information is transmitted. As is likewise shown in Figure 4, the  
20 transmission power can be increased during this frame 3 that is operated in the slotted mode, in order to achieve a transmission quality which is not adversely affected by the slotted mode.

25 However, the slotted mode interrupts the principle of fast power control. In modern mobile radio systems, power adjustment information for the transmitter is produced in each timeslot, so that the transmission power can be adapted relatively quickly. However, no  
30 such power adjustment information can be transmitted during the idle slots described above. Firstly, this results in a higher error rate for the power adjustment information bits and, secondly, it must be expected

that the instantaneous transmission power will deviate to a greater extent from the nominal value.

In order to overcome this problem associated with the  
5 slotted mode, it has been proposed, for example, to temporally increase the energy in what are referred to as pilot bits after the slotted mode,

for power control, in order to allow correct decoding of the power adjustment information, which is generally formed only by a corresponding bit with a specific mathematical sign. The pilot bits are used to estimate  
5 the channel impulse response during what is referred to as a training sequence, and correspond to a known bit pattern. The power control procedure for the slotted mode as described in this document is, however, relatively complicated, and requires a relatively large  
10 amount of effort.

The present invention is thus based on the object of proposing an improved method for controlling the transmission power in a radio system, and of proposing  
15 a corresponding radio system, in which case the aim is to reliably control the transmission power in particular even in the slotted mode or compressed mode described above.

20 According to the invention, this object is achieved by a method having the features of claim 1, and by a radio system having the features of claim 12. The depending claims each define preferred embodiments of the present invention.

25 The invention proposes that the same power adjustment information be transmitted in successive timeslots, so that the transmission power in the transmitter can be set with greater reliability, by evaluating the power  
30 adjustment information received during these timeslots in combination in order to adjust the transmission power.

The invention is particularly suitable for use in what is referred to as the slotted mode, in which case the same power adjustment information is transmitted a number of times following an idle slot, that is to say  
5 a section of a frame in which no information is transmitted. However, the invention is not restricted to this use in the slotted mode, that is to say

the invention can in principle also be used for timeslots which do not follow an idle slot, in order to allow more reliable power control in these situations as well. In this case, this approach is of particular  
5 interest when the transmission conditions in the respective transmission channel are not changing rapidly (for example when a mobile station is moving at slow speed).

10 In particular, the invention proposes that the signal-to-noise ratio of the received signal be evaluated, for example, after an idle slot, that appropriate power adjustment information be produced as a function of this, and that this information be transmitted to the  
15 transmitter during the next two timeslots immediately following the idle slot. The transmitter then evaluates the power adjustment information received during these two timeslots and adjusts the transmission power taking account of both power adjustment information items, so  
20 that a transmission power adjustment which may have been made on the basis of the first power adjustment information item can still be corrected.

The principle on which the present invention is based  
25 can be used both in the uplink, that is to say for transmitting communication information from a mobile station to a base station, and in the downlink, that is to say for the opposite direction, or else for both directions at the same time.

30 After receiving the power adjustment information in the first timeslot immediately following the idle slot, the transmission power can initially be kept constant, so

that no change is made until the power adjustment information in the second timeslot has been received.

Generally, the power adjustment information transmitted  
5 during each timeslot comprises only one bit, with the step width for changing the transmission power



being coded digitally. However, instead of this, the step width can also be coded in analogue form, that is to say the step width then depends, for example, directly analogously on the discrepancy between the received signal level measured in the receiver and a predetermined reference value.

The invention requires no change whatsoever to the specified timeslot format. The combination of the successively transmitted power adjustment information items results in an improvement in the available bit-signal-noise ratio ( $E_b/N_0$ ). This increased bit-signal-noise ratio allows a greater step width to be provided for power control without any risk of an increased bit error rate more frequently resulting in the transmission power needing to be changed in the wrong direction.

The invention can be used in various types of radio system, although the present invention is of particular interest for mobile radio systems using code division multiplexing methods (code division multiple access CDMA).

The invention will be explained in more detail in the following text with reference to the drawing, based on preferred exemplary embodiments.

Figure 1 shows an illustration to explain the principle on which the invention is based, on the basis of a preferred exemplary embodiment,

Figure 2 shows a general schematic illustration to explain the information transmission in a mobile radio system,

- 5 Figure 3 shows the frame and timeslot structure for what is referred to as a downlink connection, according to the present standard of UMTS Standardization, and

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65  
66  
67  
68  
69  
70  
71  
72  
73  
74  
75  
76  
77  
78  
79  
80  
81  
82  
83  
84  
85  
86  
87  
88  
89  
90  
91  
92  
93  
94  
95  
96  
97  
98  
99  
100  
101  
102  
103  
104  
105  
106  
107  
108  
109  
110  
111  
112  
113  
114  
115  
116  
117  
118  
119  
120  
121  
122  
123  
124  
125  
126  
127  
128  
129  
130  
131  
132  
133  
134  
135  
136  
137  
138  
139  
140  
141  
142  
143  
144  
145  
146  
147  
148  
149  
150  
151  
152  
153  
154  
155  
156  
157  
158  
159  
160  
161  
162  
163  
164  
165  
166  
167  
168  
169  
170  
171  
172  
173  
174  
175  
176  
177  
178  
179  
180  
181  
182  
183  
184  
185  
186  
187  
188  
189  
190  
191  
192  
193  
194  
195  
196  
197  
198  
199  
200  
201  
202  
203  
204  
205  
206  
207  
208  
209  
210  
211  
212  
213  
214  
215  
216  
217  
218  
219  
220  
221  
222  
223  
224  
225  
226  
227  
228  
229  
230  
231  
232  
233  
234  
235  
236  
237  
238  
239  
240  
241  
242  
243  
244  
245  
246  
247  
248  
249  
250  
251  
252  
253  
254  
255  
256  
257  
258  
259  
260  
261  
262  
263  
264  
265  
266  
267  
268  
269  
270  
271  
272  
273  
274  
275  
276  
277  
278  
279  
280  
281  
282  
283  
284  
285  
286  
287  
288  
289  
290  
291  
292  
293  
294  
295  
296  
297  
298  
299  
300  
301  
302  
303  
304  
305  
306  
307  
308  
309  
310  
311  
312  
313  
314  
315  
316  
317  
318  
319  
320  
321  
322  
323  
324  
325  
326  
327  
328  
329  
330  
331  
332  
333  
334  
335  
336  
337  
338  
339  
340  
341  
342  
343  
344  
345  
346  
347  
348  
349  
350  
351  
352  
353  
354  
355  
356  
357  
358  
359  
360  
361  
362  
363  
364  
365  
366  
367  
368  
369  
370  
371  
372  
373  
374  
375  
376  
377  
378  
379  
380  
381  
382  
383  
384  
385  
386  
387  
388  
389  
390  
391  
392  
393  
394  
395  
396  
397  
398  
399  
400  
401  
402  
403  
404  
405  
406  
407  
408  
409  
410  
411  
412  
413  
414  
415  
416  
417  
418  
419  
420  
421  
422  
423  
424  
425  
426  
427  
428  
429  
430  
431  
432  
433  
434  
435  
436  
437  
438  
439  
440  
441  
442  
443  
444  
445  
446  
447  
448  
449  
450  
451  
452  
453  
454  
455  
456  
457  
458  
459  
460  
461  
462  
463  
464  
465  
466  
467  
468  
469  
470  
471  
472  
473  
474  
475  
476  
477  
478  
479  
480  
481  
482  
483  
484  
485  
486  
487  
488  
489  
490  
491  
492  
493  
494  
495  
496  
497  
498  
499  
500  
501  
502  
503  
504  
505  
506  
507  
508  
509  
510  
511  
512  
513  
514  
515  
516  
517  
518  
519  
520  
521  
522  
523  
524  
525  
526  
527  
528  
529  
530  
531  
532  
533  
534  
535  
536  
537  
538  
539  
540  
541  
542  
543  
544  
545  
546  
547  
548  
549  
550  
551  
552  
553  
554  
555  
556  
557  
558  
559  
560  
561  
562  
563  
564  
565  
566  
567  
568  
569  
570  
571  
572  
573  
574  
575  
576  
577  
578  
579  
580  
581  
582  
583  
584  
585  
586  
587  
588  
589  
590  
591  
592  
593  
594  
595  
596  
597  
598  
599  
600  
601  
602  
603  
604  
605  
606  
607  
608  
609  
610  
611  
612  
613  
614  
615  
616  
617  
618  
619  
620  
621  
622  
623  
624  
625  
626  
627  
628  
629  
630  
631  
632  
633  
634  
635  
636  
637  
638  
639  
640  
641  
642  
643  
644  
645  
646  
647  
648  
649  
650  
651  
652  
653  
654  
655  
656  
657  
658  
659  
660  
661  
662  
663  
664  
665  
666  
667  
668  
669  
670  
671  
672  
673  
674  
675  
676  
677  
678  
679  
680  
681  
682  
683  
684  
685  
686  
687  
688  
689  
690  
691  
692  
693  
694  
695  
696  
697  
698  
699  
700  
701  
702  
703  
704  
705  
706  
707  
708  
709  
710  
711  
712  
713  
714  
715  
716  
717  
718  
719  
720  
721  
722  
723  
724  
725  
726  
727  
728  
729  
730  
731  
732  
733  
734  
735  
736  
737  
738  
739  
740  
741  
742  
743  
744  
745  
746  
747  
748  
749  
750  
751  
752  
753  
754  
755  
756  
757  
758  
759  
760  
761  
762  
763  
764  
765  
766  
767  
768  
769  
770  
771  
772  
773  
774  
775  
776  
777  
778  
779  
780  
781  
782  
783  
784  
785  
786  
787  
788  
789  
790  
791  
792  
793  
794  
795  
796  
797  
798  
799  
800  
801  
802  
803  
804  
805  
806  
807  
808  
809  
810  
811  
812  
813  
814  
815  
816  
817  
818  
819  
820  
821  
822  
823  
824  
825  
826  
827  
828  
829  
830  
831  
832  
833  
834  
835  
836  
837  
838  
839  
840  
841  
842  
843  
844  
845  
846  
847  
848  
849  
850  
851  
852  
853  
854  
855  
856  
857  
858  
859  
860  
861  
862  
863  
864  
865  
866  
867  
868  
869  
870  
871  
872  
873  
874  
875  
876  
877  
878  
879  
880  
881  
882  
883  
884  
885  
886  
887  
888  
889  
890  
891  
892  
893  
894  
895  
896  
897  
898  
899  
900  
901  
902  
903  
904  
905  
906  
907  
908  
909  
910  
911  
912  
913  
914  
915  
916  
917  
918  
919  
920  
921  
922  
923  
924  
925  
926  
927  
928  
929  
930  
931  
932  
933  
934  
935  
936  
937  
938  
939  
940  
941  
942  
943  
944  
945  
946  
947  
948  
949  
950  
951  
952  
953  
954  
955  
956  
957  
958  
959  
960  
961  
962  
963  
964  
965  
966  
967  
968  
969  
970  
971  
972  
973  
974  
975  
976  
977  
978  
979  
980  
981  
982  
983  
984  
985  
986  
987  
988  
989  
990  
991  
992  
993  
994  
995  
996  
997  
998  
999  
1000  
1001  
1002  
1003  
1004  
1005  
1006  
1007  
1008  
1009  
1010  
1011  
1012  
1013  
1014  
1015  
1016  
1017  
1018  
1019  
1020  
1021  
1022  
1023  
1024  
1025  
1026  
1027  
1028  
1029  
1030  
1031  
1032  
1033  
1034  
1035  
1036  
1037  
1038  
1039  
1040  
1041  
1042  
1043  
1044  
1045  
1046  
1047  
1048  
1049  
1050  
1051  
1052  
1053  
1054  
1055  
1056  
1057  
1058  
1059  
1060  
1061  
1062  
1063  
1064  
1065  
1066  
1067  
1068  
1069  
1070  
1071  
1072  
1073  
1074  
1075  
1076  
1077  
1078  
1079  
1080  
1081  
1082  
1083  
1084  
1085  
1086  
1087  
1088  
1089  
1090  
1091  
1092  
1093  
1094  
1095  
1096  
1097  
1098  
1099  
1100  
1101  
1102  
1103  
1104  
1105  
1106  
1107  
1108  
1109  
1110  
1111  
1112  
1113  
1114  
1115  
1116  
1117  
1118  
1119  
1120  
1121  
1122  
1123  
1124  
1125  
1126  
1127  
1128  
1129  
1130  
1131  
1132  
1133  
1134  
1135  
1136  
1137  
1138  
1139  
1140  
1141  
1142  
1143  
1144  
1145  
1146  
1147  
1148  
1149  
1150  
1151  
1152  
1153  
1154  
1155  
1156  
1157  
1158  
1159  
1160  
1161  
1162  
1163  
1164  
1165  
1166  
1167  
1168  
1169  
1170  
1171  
1172  
1173  
1174  
1175  
1176  
1177  
1178  
1179  
1180  
1181  
1182  
1183  
1184  
1185  
1186  
1187  
1188  
1189  
1190  
1191  
1192  
1193  
1194  
1195  
1196  
1197  
1198  
1199  
1200  
1201  
1202  
1203  
1204  
1205  
1206  
1207  
1208  
1209  
1210  
1211  
1212  
1213  
1214  
1215  
1216  
1217  
1218  
1219  
1220  
1221  
1222  
1223  
1224  
1225  
1226  
1227  
1228  
1229  
1230  
1231  
1232  
1233  
1234  
1235  
1236  
1237  
1238  
1239  
1240  
1241  
1242  
1243  
1244  
1245  
1246  
1247  
1248  
1249  
1250  
1251  
1252  
1253  
1254  
1255  
1256  
1257  
1258  
1259  
1260  
1261  
1262  
1263  
1264  
1265  
1266  
1267  
1268  
1269  
1270  
1271  
1272  
1273  
1274  
1275  
1276  
1277  
1278  
1279  
1280  
1281  
1282  
1283  
1284  
1285  
1286  
1287  
1288  
1289  
1290  
1291  
1292  
1293  
1294  
1295  
1296  
1297  
1298  
1299  
1300  
1301  
1302  
1303  
1304  
1305  
1306  
1307  
1308  
1309  
1310  
1311  
1312  
1313  
1314  
1315  
1316  
1317  
1318  
1319  
1320  
1321  
1322  
1323  
1324  
1325  
1326  
1327  
1328  
1329  
1330  
1331  
1332  
1333  
1334  
1335  
1336  
1337  
1338  
1339  
1340  
1341  
1342  
1343  
1344  
1345  
1346  
1347  
1348  
1349  
1350  
1351  
1352  
1353  
1354  
1355  
1356  
1357  
1358  
1359  
1360  
1361  
1362  
1363  
1364  
1365  
1366  
1367  
1368  
1369  
1370  
1371  
1372  
1373  
1374  
1375  
1376  
1377  
1378  
1379  
1380  
1381  
1382  
1383  
1384  
1385  
1386  
1387  
1388  
1389  
1390  
1391  
1392  
1393  
1394  
1395  
1396  
1397  
1398  
1399  
1400  
1401  
1402  
1403  
1404  
1405  
1406  
1407  
1408  
1409  
1410  
1411  
1412  
1413  
1414  
1415  
1416  
1417  
1418  
1419  
1420  
1421  
1422  
1423  
1424  
1425  
1426  
1427  
1428  
1429  
1430  
1431  
1432  
1433  
1434  
1435  
1436  
1437  
1438  
1439  
1440  
1441  
1442  
1443  
1444  
1445  
1446  
1447  
1448  
1449  
1450  
1451  
1452  
1453  
1454  
1455  
1456  
1457  
1458  
1459  
1460  
1461  
1462  
1463  
1464  
1465  
1466  
1467  
1468  
1469  
1470  
1471  
1472  
1473  
1474  
1475  
1476  
1477  
1478  
1479  
1480  
1481  
1482  
1483  
1484  
1485  
1486  
1487  
1488  
1489  
1490  
1491  
1492  
1493  
1494  
1495  
1496  
1497  
1498  
1499  
1500  
1501  
1502  
1503  
1504  
1505  
1506  
1507  
1508  
1509  
1510  
1511  
1512  
1513  
1514  
1515  
1516  
1517  
1518  
1519  
1520  
1521  
1522  
1523  
1524  
1525  
1526  
1527  
1528  
1529  
1530  
1531  
1532  
1533  
1534  
1535  
1536  
1537  
1538  
1539  
1540  
1541  
1542  
1543  
1544  
1545  
1546  
1547  
1548  
1549  
1550  
1551  
1552  
1553  
1554  
1555  
1556  
1557  
1558  
1559  
1560  
1561  
1562  
1563  
1564  
1565  
1566  
1567  
1568  
1569  
1570  
1571  
1572  
1573  
1574  
1575  
1576  
1577  
1578  
1579  
1580  
1581  
1582  
1583  
1584  
1585  
1586  
1587  
1588  
1589  
1590  
1591  
1592  
1593  
1594  
1595  
1596  
1597  
1598  
1599  
1600  
1601  
1602  
1603  
1604  
1605  
1606  
1607  
1608  
1609  
1610  
1611  
1612  
1613  
1614  
1615  
1616  
1617  
1618  
1619  
1620  
1621  
1622  
1623  
1624  
1625  
1626  
1627  
1628  
1629  
1630  
1631  
1632  
1633  
1634  
1635  
1636  
1637  
1638  
1639  
1640  
1641  
1642  
1643  
1644  
1645  
1646  
1647  
1648  
1649  
1650  
1651  
1652  
1653  
1654  
1655  
1656  
1657  
1658  
1659  
1660  
1661  
1662  
1663  
1664  
1665  
1666  
1667  
1668  
1669  
1670  
1671  
1672  
1673  
1674  
1675  
1676  
1677  
1678  
1679  
1680  
1681  
1682  
1683  
1684  
1685  
1686  
1687  
1688  
1689  
1690  
1691  
1692  
1693  
1694  
1695  
1696  
1697  
1698  
1699  
1700  
1701  
1702  
1703  
1704  
1705  
1706  
1707  
1708  
1709  
1710  
1711  
1712  
1713  
1714  
1715  
1716  
1717  
1718  
1719  
1720  
1721  
1722  
1723  
1724  
1725  
1726  
1727  
1728  
1729  
1730  
1731  
1732  
1733  
1734  
1735  
1736  
1737  
1738  
1739  
1740  
1741  
1742  
1743  
1744  
1745  
1746  
1747  
1748  
1749  
1750  
1751  
1752  
1753  
1754  
1755  
1756  
1757  
1758  
1759  
1760  
1761  
1762  
1763  
1764  
1765  
1766  
1767  
1768  
1769  
1770  
1771  
1772  
1773  
1774  
1775  
1776  
1777  
1778  
1779  
1780  
1781  
1782  
1783  
1784  
1785  
1786  
1787  
1788  
1789  
1790  
1791  
1792  
1793  
1794  
1795  
1796  
1797  
1798  
1799  
1800  
1801  
1802  
1803  
1804  
1805  
1806  
1807  
1808  
1809  
1810  
1811  
1812  
1813  
1814  
1815  
1816  
1817  
1818  
1819  
1820  
1821  
1822  
1823  
1824  
1825  
1826  
1827  
1828  
1829  
1830  
1831  
1832  
1833  
1834  
1835  
1836  
1837  
1838  
1839  
1840  
1841  
1842  
1843  
1844  
1845  
1846  
1847  
1848  
1849  
1850  
1851  
1852  
1853  
1854  
1855  
1856  
1857  
1858  
1859  
1860  
1861  
1862  
1863  
1864  
1865  
1866  
1867  
1868  
1869  
1870  
1871  
1872  
1873  
1874  
1875  
1876  
1877  
1878  
1879  
1880  
1881  
1882  
1883  
1884  
1885  
1886  
1887  
1888  
1889  
1890  
1891  
1892  
1893  
1894  
1895  
1896  
1897  
1898  
1899  
1900  
1901  
1902  
1903  
1904  
1905  
1906  
1907  
1908  
1909  
1910  
1911  
1912  
1913  
1914  
1915  
1916  
1917  
1918  
1919  
1920  
1921  
1922  
1923  
1924  
1925  
1926  
1927  
1928  
1929  
1930  
1931  
1932  
1933  
1934  
1935  
1936  
1937  
1938  
1939  
1940  
1941  
1942  
1943  
1944  
1945  
1946  
1947  
1948  
1949  
1950  
1951  
1952  
1953  
1954  
1955  
1956  
1957  
1958  
1959  
1960  
1961  
1962  
1963  
1964  
1965  
1966  
1967  
1968  
1969  
1970  
1971  
1972  
1973  
1974  
1975  
1976  
1977  
1978  
1979  
1980  
1981  
1982  
1983  
1984  
1985  
1986  
1987  
1988  
1989  
1990  
1991  
1992  
1993  
1994  
1995  
1996  
1997  
1998  
1999  
2000  
2001  
2002  
2003  
2004  
2005  
2006  
2007  
2008  
2009  
2010  
2011  
2012  
2013  
2014  
2015  
2016  
2017  
2018  
2019  
2020  
2021  
2022  
2023  
2024  
2025  
2026  
2027  
2028  
2029  
2030  
2031  
2032  
2033  
2034  
2035  
2036  
2037  
2038  
2039  
2040  
2041  
2042  
2043  
2044  
2045  
2046  
2047  
2048  
2049  
2050  
2051  
2052  
2053  
2054  
2055  
2056  
2057  
2058  
2059  
2060  
2061  
2062  
2063  
2064  
2065  
2066  
2067  
2068  
2069  
2070  
2071  
2072  
2073  
2074  
2075  
2076  
2077  
2078  
2079  
2080  
2081  
2082  
2083  
2084  
2085  
2086  
2087  
2088  
2089  
2090  
2091  
2092  
2093  
2094  
2095  
2096  
2097  
2098  
2099  
2100  
2101  
2102  
2103  
2104  
2105  
2106  
2107  
2108  
2109  
2110  
2111  
2112  
2113  
2114  
2115  
2116  
2117  
2118  
2119  
2120  
2121  
2122  
2123  
2124  
2125  
2126  
2127  
2128  
2129  
2130  
2131  
2132  
2133  
2134  
2135  
2136  
2137  
2138  
2139  
2140  
2141  
2142  
2143  
2144  
2145  
2146  
2147  
2148  
2149  
2150  
2151  
2152  
2153  
2154  
2155  
2156  
2157  
2158  
2159  
2160  
2161  
2162  
2163  
2164  
2165  
2166  
2167  
2168  
2169  
2170  
2171  
2172  
2173  
2174  
2175  
2176  
2177  
2178  
2179  
2180  
2181  
2182  
2183  
2184  
2185  
2186  
2187  
2188  
2189  
2190  
2191  
2192  
2193  
2194  
2195  
2196  
2197  
2198  
2199  
2200  
2201  
2202  
2203  
2204  
2205  
2206  
2207  
2208  
2209

Figure 4 shows an illustration to explain the frame structure in what is referred to as the slotted mode.

The principle of power control will first of all be explained in more detail with reference to Figure 2, with Figure 2 illustrating the communication between a base station 1 and a mobile station 2 in a mobile radio system. A connection from the base station 1 to the mobile part 2 is referred to as a downlink or forward link, while a connection from the mobile part 2 to the base station 1 is referred to as an uplink or reverse link. For downlink power control, the respective received signal is evaluated in the mobile station 2, and power adjustment information or power control information is produced as a function of it, and is sent back to the base station 1, so that the base station 1 can set the transmission power as appropriate. For uplink control, the received signal is evaluated in the base station 1, where the power control information is produced, and the mobile station 2 is instructed to carry out power adaptation.

The power control information is in this case transmitted embedded in a predetermined frame structure, depending on the respective mobile radio system.

As an example, Figure 3 shows the frame and timeslot structure for a downlink connection in a mobile radio system which is operated using a code division multiple access method (CDMA). The frame and timeslot structure shown in Figure 3 corresponds in particular to a UMTS mobile radio channel (Universal Mobile Telecommunications System), which is also referred to

as a DPCH (Dedicated Physical CHannel), in accordance with the current state of UMTS Standardization. UMTS is the designation for third-generation mobile radio systems, aiming to provide a worldwide, universal  
5 mobile radio standard. According to the UMTS mobile radio standard, the multiple access method is what is referred to as the

WCDMA method (Wideband Code Division Multiple Access).

The frame structure shown in Figure 3 has a duration of 720 ms and comprises, in particular, 72 identically constructed frames 3 with a frame duration of 10 ms, with each frame in turn having 16 timeslots 4, each with a timeslot duration of 0.625 ms. Alternatively, a frame 3 may also comprise 15 correspondingly longer timeslots 4. However, the former situation is assumed in the following text. Each timeslot 4 comprises information which is split between a logical control channel (DPCCH, Dedicated Physical Control Channel) and a logical data channel (DPDCH, Dedicated Physical Data Channel). The DPCCH section comprises a pilot bit sequence 5 and what is referred to a TPC information (Transmitter Power Control) 6 and TFI information (Transmitter Format Identifier) 7. The DPDCH section comprises user data bits 8.

The pilot bit sequence 5 is used for estimating the channel impulse response during what is referred to as a training sequence, and corresponds to a known bit pattern. The receiver can determine or estimate the channel impulse response of the mobile radio channel by comparing the received signal with the known pilot bit sequence.

The TFI information 7 is used for format identification for the respective receiver. The TFI bits are protected by means of their own coding method in accordance with the present WCDMA standard, and are distributed over an entire frame (time period 10 ms) by interleaving. If, for example, the TFI information 7 in each timeslot comprises two bits, then this results in a total of



transmission power. For this purpose, the received power or the signal-to-noise ratio of the received signal is compared with a predetermined reference value in the receiver, and the value for the power adjustment command is determined as a function of the discrepancy. This means that, if the received power exceeds the reference value, a command is produced to reduce the transmission power, while a command to increase the transmission power is produced if the received power is less than the predetermined reference value. Thus, depending on the comparison result, the receiver thus transmits a digital or binary adjustment command to the transmitter. In this case, a command to increase the transmission power (power up command) is coded by a 1, while a command to reduce the transmission power (power down command) is coded by a zero. In each case, the adjustment command is transmitted to the transmitter after appropriate modulation. In accordance with the currently discussed WDCMA Standard for UMTS mobile radio systems, the transmission is carried out by means of QPSK modulation (Quadrature Phase Shift Keying), as a result of which the binary 1 or 0, respectively, is mapped onto the value -1 or +1, respectively, with subsequent spreading of the power control signal.

25

The power adjustment or power control information thus generally comprises only one bit, which indicates whether the transmission power should be increased or decreased at the transmission end. In order to allow this bit to be transmitted with a sufficiently low error probability, the bit is transmitted repeatedly within the TPC field 6. The TPC information shown in Figure 3 in consequence comprises, for example, the

three bits which are transmitted successively with identical information content.

However, despite the repeated transmission of the TPC  
5 bits within the TPC field 6, the error rate is increased by the previously described slotted mode or compressed mode. In order to counteract this, before [lacuna]



information 6 to be transmitted repeatedly, with this being done especially during the two timeslots 4 which immediately follow the idle slot 9.

5 In order to explain this principle, Figure 1 shows, by way of example, the structure of the already previously mentioned DPCCH control channel (see Figure 3) in a frame, assuming that the timeslots #n shown in Figure 1, is the timeslot immediately following is an idle  
10 slot, that is to say a section which is not filled with information. The profile of the transmission power, which is set in the transmitter as a function of the respectively transmitted TPC information, is shown underneath the timeslot structure.

15 In the receiver, the signal-to-noise ratio of the signal being received from the transmitter at that time is measured in order to determine the TPC or power adjustment information to be transmitted during the  
20 timeslot #n, is compared with a reference value and is used to produce the TPC information  $TPC_n$ . This TPC information is transmitted to the transmitter during the timeslot #n, where it is decoded and used to adjust the transmission power. In this case, it is possible to  
25 wait first of all in the transmitter for reception of the TPC information  $TPC_{n+1}$  transmitted during the next timeslot #n+1, before finally setting the transmission power to the desired value, so that it is recommended that the transmission power initially be set in the  
30 transmitter in accordance with a "normal" nominal step width, which corresponds to a normal  $E_b/N_0$  ratio, after receiving the TPC information  $TPC_n$ . This step width is indicated by  $\Delta P_n$  in Figure 1, and corresponds to the difference between the instantaneous

transmission power  $P_{n-1}$  and the transmission power  $P_n$  set after reception of the TPC information  $TPC_n$ . The value 0 may also be chosen as the step width  $\Delta P_n$  after reception of the power adjustment information  $TPC_n$ , in  
5 order to keep the transmission power constant until the power adjustment information  $TPC_{n+1}$  is received, since it is then possible to make a decision

on the transmission power to be set, with greater reliability.

In order to produce the TPC information to be  
5 transmitted during the next timeslot #n+1, the TPC  
information from the previous timeslot is simply  
repeated, that is to say  $TPC_{n+1} = TPC_n$ , rather than  
evaluating the signal-to-noise ratio of the  
transmission signal once again. In this way, the ratio  
10  $E_b/N_0$  can be increased since, after receiving the  
timeslot #n+1, the TPC information  $TPC_{n+1}$  can be  
combined with the already previously received TPC  
information  $TPC_n$ , and the transmitter is thus able to  
set the transmission power to the desired value with  
15 greater reliability. If, for example, the transmitter  
identifies the fact that the decision made as a  
consequence of the most recently received TPC  
information was incorrect, this can now be corrected.  
As shown in Figure 1, the transmitter can now also  
20 change the transmission power with a larger step width,  
thus reducing the risk of a further deterioration being  
caused after an incorrect TPC decision. This is  
indicated in Figure 1 by  $\Delta P_{n+1}$ , with both  $\Delta P_n$  and  $\Delta P_{n+1}$   
indicating the step width with respect to the  
25 transmission power  $P_{n-1}$  set after the idle slot.

The principle, mentioned above, of repeated  
transmission of the same TPC information during  
successive timeslots can be applied not only to the  
30 first time after an interruption in the power control  
by the idle slot, but also during a normal connection.  
In this case, this is of particular interest for those  
situations in which the transmission channel does not  
change so fast with time, since the disadvantage,

associated with the method, of an increased delay in the power control can then be more than compensated for by the advantage of better quality of the transmitted power adjustment information. Since the smallest step width for power control is currently 1 dB and, for implementation reasons, smaller

values are not suitable for use in mobile stations, this provides a possible way to reduce the power control rate.

5 Furthermore, the invention can be used to transmit the power adjustment information with a smaller number of TPC bits. Although this reduces the bit-signal-noise ratio ( $E_b/N_0$ ), this can be compensated for, however, by the advantage of the invention, namely by increased  
10 transmission reliability. The use of a small number of TPC bits is advantageous to the extent that this reduces what is referred to as the overhead, and the efficiency can thus be improved.

15 Furthermore, the present invention can also advantageously be used for what is referred to as a soft handover. In this case, the mobile station 2 transmits and receives data from and to a number of base stations 1. To detect the user data, the received  
20 signals from all the connections are combined, thus allowing the power of each individual connection to be reduced. The TPC power adjustment commands may, however, in general not be combined, since the TPC power adjustment commands sent from different base  
25 stations 1 (via a downlink) need not be identical. Since the TPC power adjustment commands must also be evaluated very quickly, it is also generally impossible to combine them in the uplink. Otherwise, intolerable delays would occur, caused by the corresponding  
30 information being passed on from one base station 1 to another base station 1. In addition to increasing the power level of the number of TPC bits, this could be overcome by use of the present invention.

Finally, the previously described invention can also be combined with the principle of analogue transmission of the step width for adjustment of the transmission power. In this case, the transmission power to be set

5 in the transmitter and the

corresponding step width are coded in analogue form rather than digitally, that is to say the power adjustment information is in each case set in analogue form depending on the discrepancy between the measured  
5 received signal level and the predetermined reference value, for example the pilot bit reception level. A discrepancy that is twice as great between the received signal level and the reference value thus results in a step width which is twice as large.

## Patent Claims

1. A method for controlling the transmission power in a radio system,
- 5 with information being transmitted, embedded in a frame and a timeslot structure (3, 4), between a transmitter (2; 1) and a receiver (1; 2), with a signal, which is received by the receiver (1; 2) via a transmission channel in the radio system, from
- 10 the transmitter (2; 1) being evaluated and power adjustment information (6) being produced as a function of this in each timeslot (4) and being sent to the transmitter (2; 1), and
- with the transmission power in the transmitter (2; 1)
- 15 being adjusted as a function of the power adjustment information (6),
- characterized
- in that identical power adjustment information (6) is transmitted from the receiver (1; 2) to the transmitter
- 20 (2; 1) in a number of successive timeslots (4).
2. The method as claimed in claim 1,
- with the information being transmitted in compressed form in a specific frame (3), so that there is a
- 25 section (9) which is not filled with information within this frame (3),
- characterized
- in that, following a section (9) of a frame (3) which is not filled with information, the receiver (1; 2)
- 30 transmits identical power adjustment information (6) to the transmitter (2; 1) in a number of successive timeslots (4).



3. The method as claimed in claim 2,  
characterized  
in that, following the section (9) which is not filled  
with information, the receiver (1; 2) transmits  
5 identical power adjustment information (6) to the  
transmitter (2; 1) in two successive timeslots (4).

4. The method as claimed in claim 3,  
characterized

in that the transmission power in the transmitter (2;  
1) is adjusted as a function of both power adjustment  
5 information (6) received in the first timeslot (4)  
following the section which is not filled with  
information, and power adjustment information (6) which  
is received in the second section (9) following the  
section (9) which is not filled with information.

10

5. The method as claimed in claim 3 or 4,  
characterized

in that the signal received by the receiver (1; 2) from  
the transmitter (2; 1) is evaluated once again only  
15 after the transmission of the identical power  
adjustment information (6) in the first and second  
timeslots (4) following the section (9) which is not  
filled with information, and new power adjustment  
information is produced as a function of this, and is  
20 sent to the transmitter (2; 1) in the next timeslot  
(4).

6. The method as claimed in one of claims 3-5,  
characterized

25 in that the transmission power in the transmitter (2;  
1) is changed by a fixed amount ( $\Delta P_n$ ) after receiving  
the power adjustment information transmitted in the  
first timeslot (4) following the section (9) which is  
not filled with information, and in that, after  
30 receiving the power adjustment information (6)  
transmitted during the second timeslot (4) following  
the section (9) which is not filled with information,  
and taking account of the power adjustment information  
(6) transmitted during the first timeslot (4) following

the section (9) which is not filled with information, a power change value ( $\Delta P_{n+1}$ ) is determined, and the transmission power in the transmitter (2; 1) is changed in accordance with this power change value ( $\Delta P_{n+1}$ ) relative to the transmission power ( $P_{n-1}$ ) set prior to the first change.

5

7. The method as claimed in claim 6,  
characterized  
in that the fixed magnitude ( $\Delta P_n$ ) corresponds to the  
value zero.

5

8. The method as claimed in one of the preceding  
claims,  
characterized

in that, in the receiver (1; 2), the power adjustment  
10 information (6) is produced analogously as a function  
of the discrepancy between a specific evaluated  
parameter in the received signal and a corresponding  
reference value.

15 9. The method as claimed in one of the claims 2-8,  
characterized  
in that identical power adjustment information (6) is  
also transmitted to the transmitter (2; 1) in a number  
of successive timeslots (4) which do not immediately  
20 follow the section (9) which is not filled with  
information, and  
in that the transmission power in the transmitter (2;  
1) is adjusted taking account of the power adjustment  
information received during these timeslots (4).

25

10. The method as claimed in one of claims 2-9,  
characterized  
in that identical power adjustment information (6) is  
transmitted to the transmitter (2; 1) a number of times  
30 in successive timeslots (4) following a section (9)  
which is not filled with information, with the number  
of repetitions being different on each occasion.

11. The method as claimed in one of the preceding claims,

characterized

in that the method is used during a soft handover in

5 the mobile radio system.

12. A radio system,  
having a transmitter (2; 1), and  
having a receiver (1; 2) for receiving a signal, which  
is transmitted via a transmission channel in the radio  
5 system, from the transmitter (2; 1), and for evaluating  
the received signal in order to produce power  
adjustment information (6) as a function of it, and to  
send this information (6) to the transmitter (2; 1),  
with the transmitter (2; 1) being designed such that it  
10 adjusts the transmission power as a function of the  
power adjustment information from the receiver (1; 2),  
with information being transmitted, embedded in a frame  
and a timeslot structure (3, 4), between the  
transmitter (2; 1) and the receiver (1; 2), with a  
15 signal,  
characterized  
in that the receiver (1; 2) is designed such that it  
transmits identical power adjustment information (6) to  
the transmitter (2; 1) in a number of successive  
20 timeslots (4).

13. The radio system as claimed in claim 12,  
with the information being transmitted in compressed  
form in a specific frame (3), so that there is a  
25 section (9) which is not filled with information within  
this frame (3),  
characterized  
in that the receiver (1; 2) is designed such that it  
transmits identical power information (6) to the

transmitter (2; 1) in a number of successive timeslots (4) following a section (9) which is not filled with information in a frame (3).

- 5 14. The radio systems claimed in claim 13, characterized in that the receiver (1; 2) is designed such that it transmits identical power adjustment information (6) to the transmitter (2; 1) in two

successive timeslots (4) following the section (9) which is not filled with information.

15. The radio system as claimed in claim 14,  
5 characterized  
in that the transmitter (2; 1) is designed such that it adjusts the transmission power as a function of both power adjustment information (6) received in the first  
10 timeslot (4) following the section which is not filled with information, and power adjustment information (6) which is received in the second section (9) following the section (9) which is not filled with information.

16. The radio system as claimed in claim 14 or 15,  
15 characterized  
in that the receiver (1; 2) is designed such that it once again evaluates the signal, received by the receiver (1; 2) from the transmitter (2; 1) after the transmission of the identical power adjustment  
20 information (6) in the first and second timeslots (4) following the section (9) which is not filled with information, and produces new power adjustment information as a function of this, and sends this information to the transmitter (2; 1) in the next  
25 timeslot (4).

17. The radio system as claimed in one of claims 13-16,  
characterized  
30 in that the transmitter (2; 1) is designed such that it changes the transmission power by a fixed amount ( $\Delta P_n$ ) after receiving the power adjustment information transmitted in the first timeslot (4) following the section (9) which is not filled with information and,



after receiving the power adjustment information (6) received during the second timeslot (4) following the section (9) which is not filled with information, and, additionally taking account of the power adjustment  
5 information (6) received during the first timeslot (4) following the section (9) which is not filled with information, it determines a power change value ( $\Delta P_{n+1}$ ), and changes the

transmission power in the transmitter (2; 1) in accordance with this power change value ( $\Delta P_{n+1}$ ).

18. The radio system as claimed in claim 17,

5 characterized

in that the fixed amount ( $\Delta P_n$ ) corresponds to the value zero, so that after receiving the power adjustment information transmitted in the first timeslot (4) following the section (9) which is not filled with  
10 information, the transmitter (2; 1) keeps the transmission power constant until reception of the power adjustment information (6) transmitted in the second timeslot (4) following the section (9) which is not filled with information.

15

19. The radio system as claimed in one of claims 12-18,

characterized

in that the receiver (1; 2) is designed such that it  
20 produces the power adjustment information (6) analogously as a function of the discrepancy between a specific evaluated parameter in the received signal and a corresponding reference value.

25 20. The radio system as claimed in one of claims 13-19,

characterized

in that the receiver (1; 2) is designed such that it also transmits identical power adjustment information  
30 (6) to the transmitter (2; 1) in a number of successive timeslots (4) which do not directly follow a section (9) which is not filled with information, and

in that the transmitter (2; 1) is designed such that it adjusts the transmission power taking account of the power adjustment information received during these timeslots (4).

5

21. The radio system as claimed in one of claims 12-20,

characterized

in that the radio system is a CDMA mobile radio system.

FIG 1

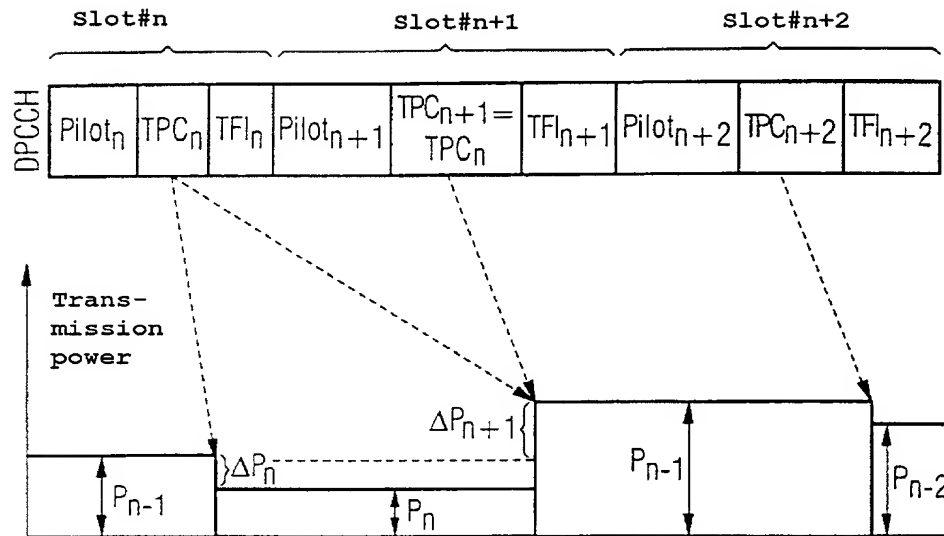
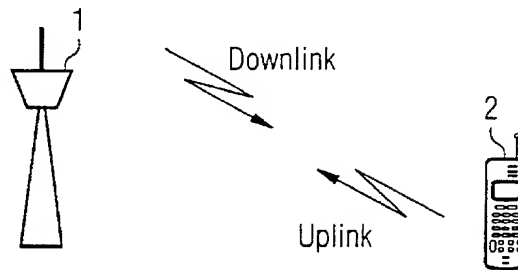


FIG 2



2/2

FIG 3

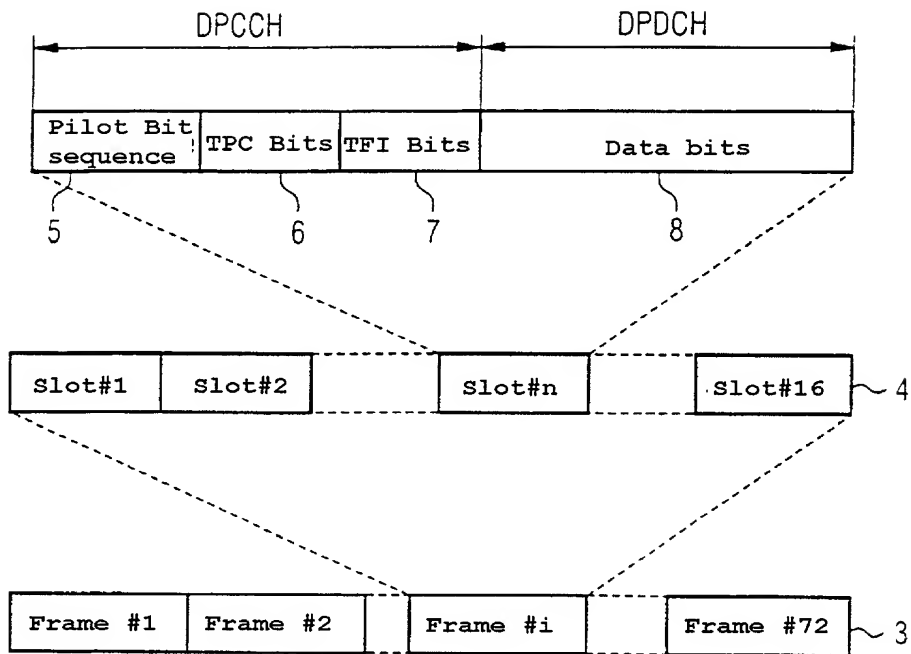
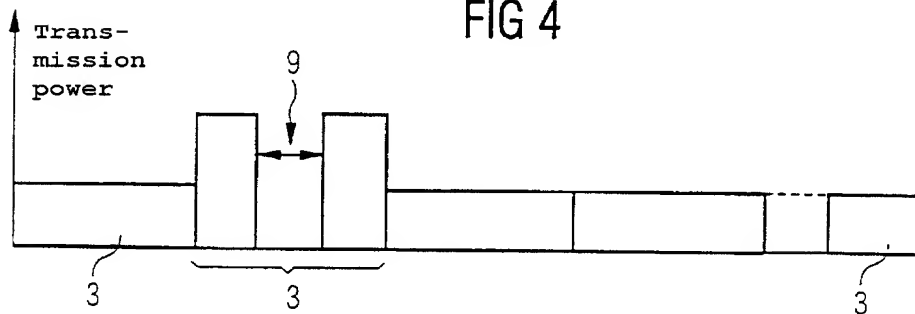


FIG 4



# Declaration and Power of Attorney For Patent Application

## Erklärung Für Patentanmeldungen Mit Vollmacht

### German Language Declaration

Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

dass mein Wohnsitz, meine Postanschrift, und meine Staatsangehörigkeit den im Nachstehenden nach meinem Namen aufgeführten Angaben entsprechen,

dass ich, nach bestem Wissen der ursprüngliche, erste und alleinige Erfinder (falls nachstehend nur ein Name angegeben ist) oder ein ursprünglicher, erster und Miterfinder (falls nachstehend mehrere Namen aufgeführt sind) des Gegenstandes bin, für den dieser Antrag gestellt wird und für den ein Patent beantragt wird für die Erfindung mit dem Titel:

Verfahren zur Regelung der  
Sendeleistung in einem Funksystem und  
entsprechendes Funksystem

deren Beschreibung

(zutreffendes ankreuzen)

☐ hier beigefügt ist.

☒ am 16.05.2000 als

PCT internationale Anmeldung

PCT Anwendungsnummer PCT/DE00/01542

eingereicht wurde und am \_\_\_\_\_

abgeändert wurde (falls tatsächlich abgeändert).

Ich bestätige hiermit, dass ich den Inhalt der obigen Patentanmeldung einschliesslich der Ansprüche durchgesehen und verstanden habe, die eventuell durch einen Zusatzantrag wie oben erwähnt abgeändert wurde.

Ich erkenne meine Pflicht zur Offenbarung irgendwelcher Informationen, die für die Prüfung der vorliegenden Anmeldung in Einklang mit Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) von Wichtigkeit sind, an.

Ich beanspruche hiermit ausländische Prioritätsvorteile gemäss Abschnitt 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 119 aller unten angegebenen Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde, und habe auch alle Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde nachstehend gekennzeichnet, die ein Anmeldedatum haben, das vor dem Anmeldedatum der Anmeldung liegt, für die Priorität beansprucht wird.

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

Method for adjusting transmission power  
in a radio system and corresponding  
radio system

the specification of which

(check one)

☐ is attached hereto.

☒ was filed on 16.05.2000 as

PCT international application

PCT Application No. PCT/DE00/01542

and was amended on \_\_\_\_\_  
(if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

# German Language Declaration

Prior foreign applications  
Priorität beansprucht

Priority Claimed

19928763.5 — DE —  
(Number) (Country)  
(Nummer) (Land)

23.06.1999 —  
(Day Month Year Filed)  
(Tag Monat Jahr eingereicht)

☒ ☐  
Yes No  
Ja Nein

(Number) (Country)  
(Nummer) (Land)

(Day Month Year Filed)  
(Tag Monat Jahr eingereicht)

☐ ☐  
Yes No  
Ja Nein

(Number) (Country)  
(Nummer) (Land)

(Day Month Year Filed)  
(Tag Monat Jahr eingereicht)

☐ ☐  
Yes No  
Ja Nein

Ich beanspruche hiermit gemäss Absatz 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 120, den Vorzug aller unten aufgeführten Anmeldungen und falls der Gegenstand aus jedem Anspruch dieser Anmeldung nicht in einer früheren amerikanischen Patentanmeldung laut dem ersten Paragraphen des Absatzes 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 122 offenbart ist, erkenne ich gemäss Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) meine Pflicht zur Offenbarung von Informationen an, die zwischen dem Anmeldedatum der früheren Anmeldung und dem nationalen oder PCT internationalen Anmeldedatum dieser Anmeldung bekannt geworden sind.

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §122, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application.

PCT/DE00/01542 —  
(Application Serial No.)  
(Anmeldeseriennummer)

16.05.2000 —  
(Filing Date D, M, Y)  
(Anmeldedatum T, M, J)

anhängig  
(Status)  
(patentiert, anhängig,  
aufgegeben)

pending  
(Status)  
(patented, pending,  
abandoned)

(Application Serial No.)  
(Anmeldeseriennummer)

(Filing Date D, M, Y)  
(Anmeldedatum T, M, J)

(Status)  
(patentiert, anhängig,  
aufgeben)

(Status)  
(patented, pending,  
abandoned)

Ich erkläre hiermit, dass alle von mir in der vorliegenden Erklärung gemachten Angaben nach meinem besten Wissen und Gewissen der vollen Wahrheit entsprechen, und dass ich diese eidesstattliche Erklärung in Kenntnis dessen abgebe, dass wissentlich und vorsätzlich falsche Angaben gemäss Paragraph 1001, Absatz 18 der Zivilprozessordnung der Vereinigten Staaten von Amerika mit Geldstrafe belegt und/oder Gefängnis bestraft werden koennen, und dass derartig wissentlich und vorsätzlich falsche Angaben die Gültigkeit der vorliegenden Patentanmeldung oder eines darauf erteilten Patentes gefährden können.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

# German Language Declaration

VERTRETUNGSVOLLMACHT: Als benannter Erfinder beauftrage ich hiermit den nachstehend benannten Patentanwalt (oder die nachstehend benannten Patentanwälte) und/oder Patent-Agenten mit der Verfolgung der vorliegenden Patentanmeldung sowie mit der Abwicklung aller damit verbundenen Geschäfte vor dem Patent- und Warenzeichenamt: (Name und Registrationsnummer anführen)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (list name and registration number)

Customer No. 29177



and I hereby appoint

29177

Telefongespräche bitte richten an:  
(Name und Telefonnummer)

Direct Telephone Calls to: (name and telephone number)

Ext. \_\_\_\_\_

Postanschrift:

Send Correspondence to:

Bell, Boyd & Lloyd LLC  
Three First National Plaza, 70 West Madison Street, Suite 3300 60602-4207 Chicago, Illinois  
Telephone: (001) 312 372 11 21 and Facsimile (001) 312 372 20 98

or

Customer No. 29177

Voller Name des einzigen oder ursprünglichen Erfinders:		Full name of sole or first inventor:	
BERNHARD RAAF		BERNHARD RAAF	
Unterschrift des Erfinders	Datum	Inventor's signature	Date
<i>Bernhard RAAF</i>	8.11.01		
Wohnsitz		Residence	
MUENCHEN, DEUTSCHLAND DEX		MUENCHEN, GERMANY	
Staatsangehörigkeit		Citizenship	
DE ✓		DE	
Postanschrift		Post Office Address	
MAXHOFSTR. 62		MAXHOFSTR. 62	
81475 MUENCHEN		81475 MUENCHEN	
Voller Name des zweiten Miterfinders (falls zutreffend):		Full name of second joint inventor, if any:	
Unterschrift des Erfinders		Second Inventor's signature	
Datum		Date	
Wohnsitz		Residence	
Staatsangehörigkeit		Citizenship	
Postanschrift		Post Office Address	

(Bitte entsprechende Informationen und Unterschriften im Falle von dritten und weiteren Miterfindern angeben).

(Supply similar information and signature for third and subsequent joint inventors).